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New Method for Iris Images Fusion

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Abstract: In this study, a new method for merging information from multiple iris images in a single image by using the effect of variance between each pixel and its 8-neighboring pixels and selecting starting maximum point in the first fused output image and minimum point in the second fused output image then constructing other pixels by selecting pixels from one of original images that make the variance with starting points in smallest state, the fused image become more informative than each of the original image and reflex more important features the fusion operation can be done among the same iris with different images to enhance the original images or can be done between left and right irises of the same person to produce more informative image that can be used in matching process of any iris in identification or verification systems. The proposed system replace left and right irises for the same person with suitable rectangle image that reflect combined features of the original images.

Key words: Iris, fusion, pupil, variance, watershed, pixel

INTRODUCTION

Biometrics is the automated techniques of measuring physical and behavioral features or characteristics of an individual in order to comparing these features with comprehensive database for the purposes of identification. The ideal biometric indicator has five qualities:

- Robustness, unchanging over time for any person
- Distinctiveness having wide differences over population
- Availability, the entire population have this measure in multiples
- Accessibility, can berecorded easily using suitable sensors
- Acceptability, people accept to having this measurement for this specific indicator (Jain *et al*., 2015, 2016)

Anaccurate biometric system consist of many variousstеps: information capture, processingin order to enhance the biometric appearance and features storage of the extracted information, comparison and as a last steptake decision based on this comparison whether it is the correct person or not. Systems like enrollment, identification and verification share the similar paths through mainsteps (Dunstone and Yager, 2008). A typical iris system has three major steps: iris localization, extract important features and matching process between saved and input images (Homayon, 2015).

Fusionis a technique of merging information from multiple sources to avoid weakling points in each source and produce enhanced version from all information sources as well as to produce more informative results depending on all the sources of information by merging and integrating the information among all sources of information. Fusion process can be applied at many levels, generally, there are four levels of fusion

Pixel-level fusion: In this level, fusion of specific images is performed pixel-bypixeleither in the spatial domain or any transformed one. All pixels with guides (i, j) of the original images is merged by suitable different rules to form the output merged pixels with guides (i, j) in the fused output image. Pixel-level fusion can be classified into three types.

Mean rule: Fusion by taking the mean of the related coefficients from each image This rule producehigh performance as in wavelet coefficients (Raol, 2016).

Maximum/minimum value rule: This methods taking either the greatest or the smallest values of the related coefficients in all mergedinput images.

Weighted combination rule: Uses suitable ratio of the coefficients either in transformed or in special domain (Raol, 2015).

Feature level fusion: Features from each sensor are extractedand merged into a single vector of features that

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represent the input to suitable techniques such as artificial neural networks systems or clustering algorithms (Wang *et al*., 2010). These features may belocal texture features extracted from single images or global texture features by evaluating the large number ofimages (Al-Asad *et al*., 2015).

Region-based image fusion: The main idea in this level is to perform a segmentation process for all original images then take the segmentation results as a guide to fusion process. The methodology, research by dividing the image into small patches. Using the splitting/merging segmentation methods, a process merged the pixels corresponding to each patch to form output contiguous suitable area of interest (Chen *et al*., 2013).

Decision-level fusion: Fusion at this level merges the decisions of unrelated and independent sensors by Boolean operations (and or) processes or by selecting a suitable ratio. The objective of symbol-level fusion is to produce accurate and reliable classification.

Image segmentation is the process of dividing images according to its characteristics like color, texture, edges and regions founded in the images. A number of images segmentation techniques are available and proposed but there is no one single technique that is good in all applications.

The watershed segmentation is an algorithm for morphological segmentation of images the most suitable description of the watershed segmentation is depend on a water shed process simulation by considering the color value of a pixel in image as anelevation level of this pixel in topographic surface the idea is to generate and construct dams lines lowest regions are slowly flooded by allowing water to rise at a uniform rate when the water from two distinct regions is about to merge, a dam is built. The flooding reach to final stage when only the dams are visible above the water surface and these represent the region lines (Inthiyaz *et al*., 2016).

Literature review: Rattani and Tistarelli (2009) proposed fusion in features-level between face and iris biometrics as well as fusion is applied to merge the data from the left and right iris images. The proposed system calculate SIFT features from these biometrics then features are finally merged into a single features vectorusing suitable fusion method.

Wang and Han (2009) focus on fusion methods of iris system to make this system reliableand accuratein person identification iris algorithm they proposed schemes of multi-algorithmic fusion by combining the improved phase algorithm with the DCT-based algorithm and multi-instance by combining features from left and right irises of a person.

Liu *et al*. (2013) proposed approaches to enhance the similarity of the Low Resolution (LR) and High Resolution (HR) iris images by using pixel-level as well as feature level fusion. They proposed a code-level scheme for matching (LR) and (HR) iris images. The comparison then performed by using this binary codesof (LR) images (HR) image based on an adapted Markov network.

Tomeo-Reyes and Chandran (2013) proposed and investigate fused methods froma multi-part and multi-sample for higher accuracy in an iris system. An implementation of the multi-part architecture and the effect of the number of parts and samples analyzed.

MATERIALS AND METHODS

Proposed system: Proposed system can be divided into the following steps:

- Watershed segmentation
- Pupil detection
- Important region detection (ROI)
- Translate circle region into rectangle region
- Fusion operation among rectangular textures

The block diagram of the proposed system is shows in Fig. 1.

Watershed segmentation: To apply watershed segmentation, the following processes will be applied.

Image enhancement: Mean filter among pixel and its 8-neibouring pixels will be used to reduce noise and enhance image to avoid the anomalies effects as shows in Fig. 2:

$$\begin{aligned} &P(i,j)new = 1/9\times(p(())+p(i-1,j)+\\ &p(i-1,j+1)+p(i,j-1)+p(i,j)+p(i,j+1)+\\ &p(i+1,j-1)+p(i+1-j)+p(i+1,j+1) \end{aligned} \quad (1)$$

Colors reduction: This process will be applied by using Suitable Factor (SF) in reducing iris gray levels in order to avoid over segmentation effect that can be produced meaningless regions which consist of large number of small segments each group of them related to suitable actual segment as illustrated in Fig. 3:

$$p(i,j)_{new} = \frac{p(i,j)_{old}}{Sf} \quad (2)$$

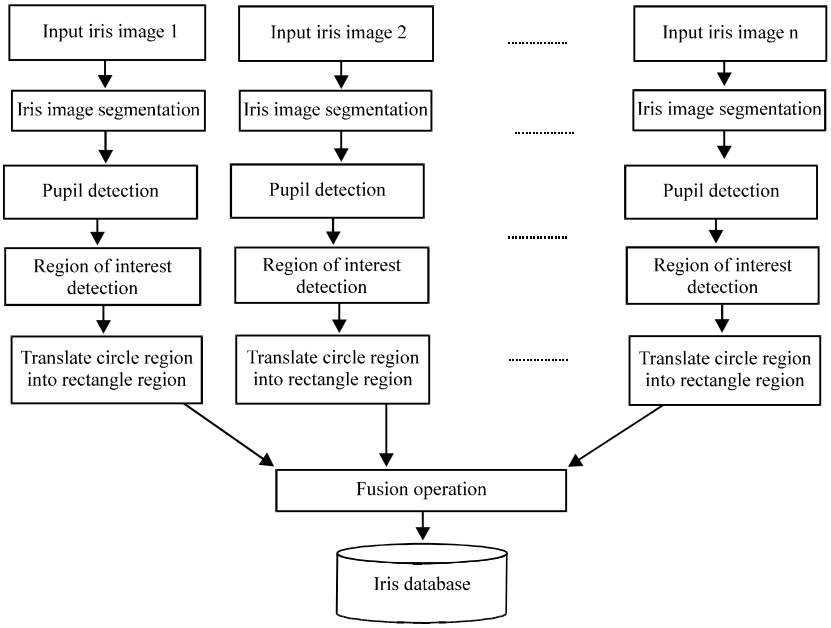

Fig. 1: Block diagram of the proposed system

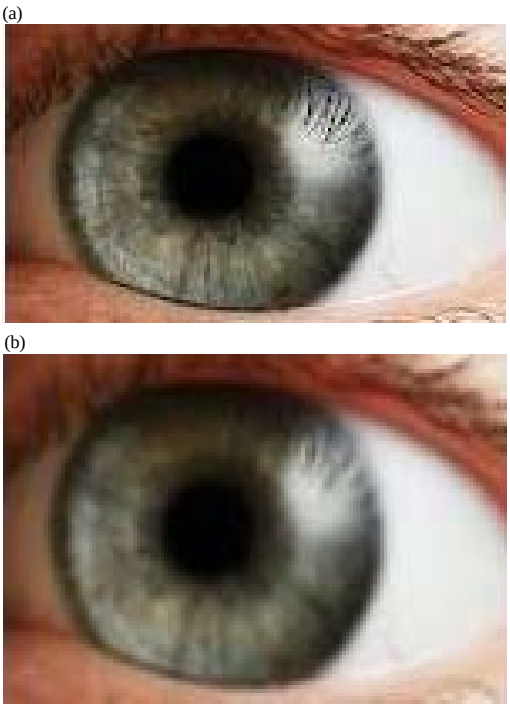

Fig. 2: Image enhancement by mean filter: a) original image and b) enhanced image

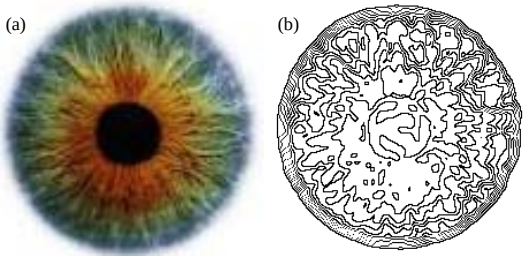

Fig. 3: Over segmentation: a) Iris image and b) segmented image

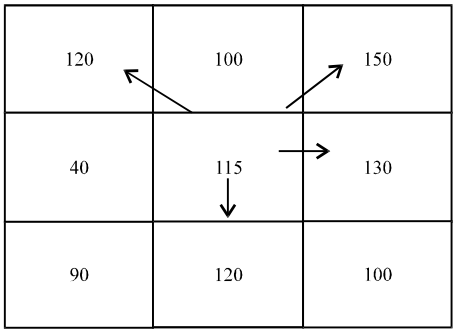

Fig. 4: Arrows drawing

Represent initial edges: By drawing arrows from each pixel to its 8-neibouring pixels that have large gray level values as illustrated in Fig. 4.

Delete spurious edges: This process will be done by deleting all arrows entered or leaved any pixel if this pixels received more than two arrows from its 8-neiboring pixels as shows in Fig. 5. Labeling pixels in each isolated regions

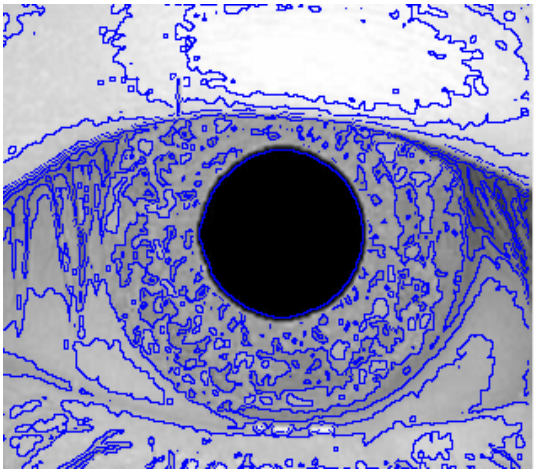

Fig. 5: Final edges detection

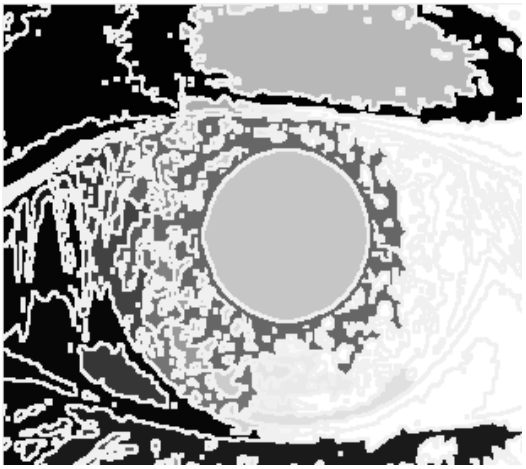

Fig. 6: Labeling images

with unique number that become feature of this region and represent the region number that can be used to retrieve all pixels in a specific segment as shows in Fig. 6.

Pupil detection: After completion of watershed segmentation, the iris pupil must be detected by searching for occurrence of specific features that isolated pupil segment from other segments and the most important features are. Pupil segment is more darker segment than other segments in iris image.

Pupil segment is a circle region that has minimum value for the ratio of the circumference to the area of the circle than any other non-circular regions. Pupil segment has specific area that can be estimated by taking upper and lower limit. Pupil detect operation can be shows in Fig. 7.

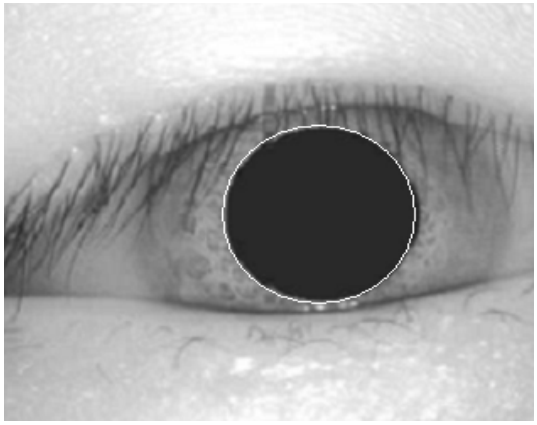

Fig. 7: Pupil detection

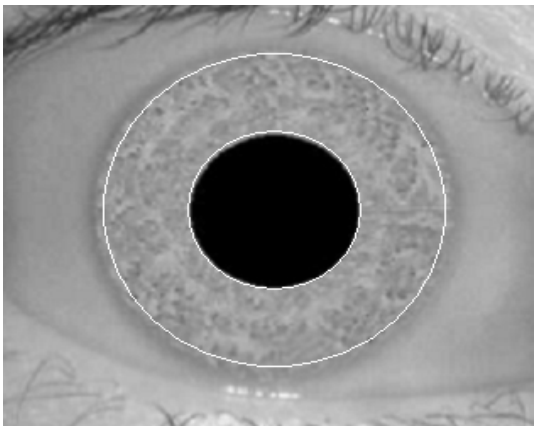

Fig. 8: Region of interest detection

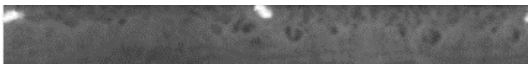

Fig. 9: Rectangular texture for iris image

Important region detection: Important region will be calculated after detecting pupil by measuring the radius of the pupil then the radius of the important region (R_{roi}) is greater than pupil radius (R_p) by (50) pixels as illustrated in Eq. 3 and Fig. 8:

$$R_{roi} = R_p + 50 \quad (3)$$

This region represent the most important features of iris region and consist of specific texture that reflect the uniqueness of iris and this texture cannot be repeated in any two irises of any two persons or of the same person as well.

Translate circle region into rectangle region: In iris system the region of interest cannot be used directly in many processes like fusion operation (Fig. 9), one of the

most important reason is the pupil radius hasn't fixed radius in all irises as well as in same iris in different states of light and concentration effects so we need to translate all irises into fixed state to simplified next processes. To perform this operation the following equations will be used:

$$P_{rectangle}(i, j) = P_{circle}(c_x + (r+j) \times \cos(i), cy + (r+j) \times \sin(i)) \quad (4)$$

Where:

c_x, c_y = Center coordinates
i = 0→359
j = 0→49
r = Pupil radius

As a result of the above operation we obtained a rectangular texture for each iris image with dimensions (360.50) as shown in Fig. 9.

RESULTS AND DISCUSSION

e-Fusion operation among rectangular textures: Fusion operation merge information from multiple sources in meaningful fashion in order to generate new image that either contain more information or become enhanced version than original images.

The proposed system used a new method in pixel level fusion by selecting maximum/minimum pixel initially in first position and then select ratio from pixels oforiginal images that have less absolute difference with center selected maximum/minimum pixel and complement ratio from the other images and this operation continue until last pixel as shows in Fig. 10. The results of the proposed system can be shows (Fig. 11 and 13).

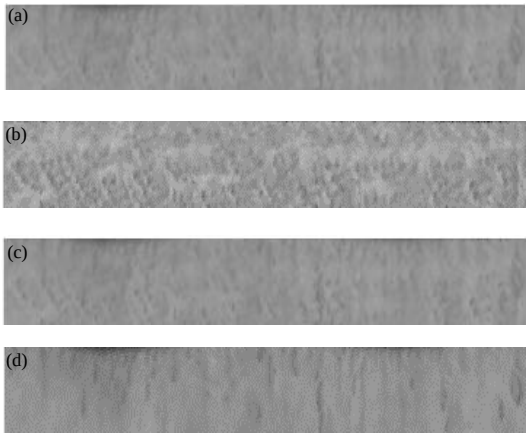

Fig. 10: Fusion results: a) Image 1 b); Image 2 c); Minimum variance with maximum and d) Minimum variance with minimum

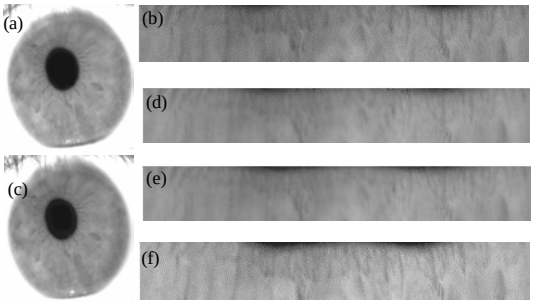

Fig. 11: Example (1) results: a) Image 1; b) Image 1 as a rectangle; c) Image 2d-image 2 as a rectangle; d) Result (1) fused image and e) result (2) fused image

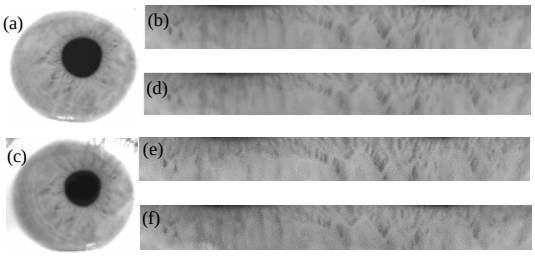

Fig. 12: Example (2) results: a) Image 1; b) Image 1 as a rectangle; c) Image 2D-image 2 as a rectangle; d) Result (1) fused image and e) Result (2) fused image

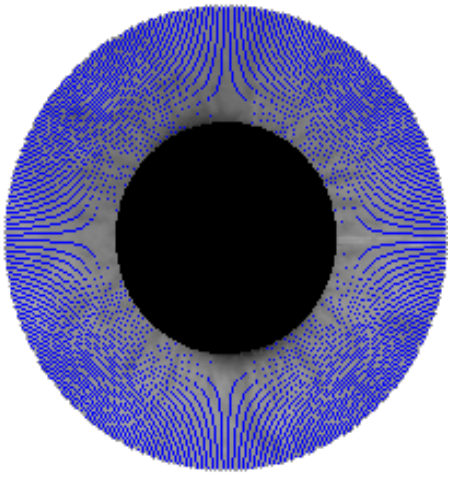

Fig. 13: Compared circle line length with corresponding rectangle line

CONCLUSION

Iris is elastic object that take many states that differ in pixels position only but the relative position between

pixels stay fixed and not effected with light changes. Watershed segmentation flexible and allow researchers free in choosing the factor (S_f) that used in gray levels reduction step to produce various degree of required accuracy according to the current state.

The step (translate circle region into rectangle region) lead to some approximation processes where the proposed system translate each circle of the interested region with range (r-r+50) into a line of pixels with length 360 and this process leads to repeat some pixels in small circles or to ignore some pixels in large circles for example if the radius of circle is 100 then the diameter of circle is (22/7×200 = 629) so we need to ignore 269 pixels and ifthe radius of circle is 30 then the diameter of circle is (22/7×60 = 188) so we need to repeat 172 pixels.

Fusion method used in the proposed system is simple in implementation and summarize iris database without approximation. This method avoid noisy parts of irises by attenuating bad effect in fusion operation without need to complex systems.

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